RENATA GELD

SANJA KIŠIČEK

KRISTINA KOCIJAN

MIRELA LANDSMAN VINKOVIĆ

DIANA TOMIĆ

COGNITIVE SCIENCE AND ITS TAKE ON CREATIVITY: CONCEPTUAL INTEGRATION IN TEACHING

PRELIMINARY COMMUNICATION
https://doi.org/10.17234/9789533791821.20

Cognitive science informs us that human creativity emerged as our working memory developed to a level that allowed us to simultaneously manage seemingly disparate or contradictory elements. The resulting cognitive mechanism, conceptual integration (Fauconnier & Turner, 2002), is believed to be responsible for generating novel meanings at the heart of creative endeavors. In this conceptual paper, supported by the outcomes of a project involving EFL teachers, German teachers, and math teachers, we explore the notion of conceptual integration as a pivotal process in driving paradigm shifts in the instruction of fundamental, albeit cognitively demanding, school subjects such as foreign languages and mathematics.

Keywords: teaching, foreign languages, math, creativity, conceptual integration, perceptual similarities, cognitive science

INTRODUCTION

Conceptual integration has been studied in various fields and disciplines: linguistics, education, music theory, social sciences, mathematics, neuroscience, artificial intelligence, contemporary art, etc. (Antović, 2018; Geld et al., 2022; Gómez-Ramírez, 2020; Lakoff & Núñez, 1997; Maldonado, 1999; Sondergaard, 1999; Thagard & Stewart, 2011; Turner, 2001; Woźny, 2018). The theory of conceptual integration or conceptual blending theory (CBT,

Fauconnier & Turner, 2002) explains human capacity to innovate as well as describes its origins and evolution. The crucial aspect of the mechanism of conceptual integration is that it operates through conceptual mappings, subconsciously, across human thought, but the results, the emergent structures, that we witness consciously seem very simple. The theory is somewhat aligned with the ideas proposed by Arthur Koestler's in *The Art of Creation* (1963), primarily his concept of bisociation (1963: 35).

However, they are far from simple. For example, the complexity of emergent meanings has been extensively discussed in the context of our ability to communicate, that is, to produce and understand language. Language is a complex system that interacts with thought, and its conceptual structure reflects general cognitive processes as well as codes various aspects of the speaker's knowledge of the world. Hence, linguistic meanings are tremendously difficult to "unpack" even for linguists and cognitive scientists. The unpacking requires looking into the human mind and describing its complex processes constituting meaning construction and emergence of meaning. However, while using language, we do not stop and attempt to deconstruct meanings. We participate in an ongoing construction of meaning, we use conceptual linguistic inventories to convey our message and understand each other, we negotiate meaning, we ask for clarifications, we hypothesize, we imagine, but we do not trace back the constituents of emergent meanings.

In short, our mind navigates the sea of mental spaces and performs numerous instances of conceptual integration, but we are largely unaware of the resulting blends. Still, certain creations are somewhat more intentional and hence more easily recognized as results of conceptual integration. An obvious example are imaginative blends intended for children, who are "geniuses at blending" (Turner, 2014: 3). Their favorite characters and stories contain numerous blends and are blends themselves: *The Runaway Bunny, The Cat in the Hat*, *Harold and Purple Crayon.* As a matter of fact, this type of blend constitutes fictional characters and plots appealing to various age groups, from young children to adults: *Spiderman, Superman, The Lord of the Rings* (Turner, 2014).

Let's revisit the statement that children are "geniuses at blending". Children rarely question the potential of animals to communicate or reason, nor do they question the notion of a person climbing like a spider. They are willing suspend their disbelief to enjoy whatever arises from the blends. They are imaginative, curious, and creative. However, their imagination, curiosity and creativity seem to decline steadily over time. This decline can be attributed largely to the assumption that schools kill creativity. The problem of schools

suffocating creativity[1] has been has a persistent concern for decades, except for specific curricular domains such as arts, music, or drama.

We firmly believe that they indeed do, although the extent varies based on factors such as the school type, learners' age, the subject being taught, national resources, and educational policies. As educators, we witness curricula packed with facts that need to be memorized and learning outcomes that are frequently detached from real-world questions and challenges. On the other hand, education that supports and thrives on creative efforts should be the *conditio sine qua non* in today's demanding society. Creative endeavors are organically aligned with transferable skills that include problem-solving and teamwork, critical and innovative thinking. If human beings are born with the capacity to be creative by being endowed with cognitive mechanisms such as conceptual integration, it is our responsibility to activate these mechanisms in education. In the sections that follow we briefly outline the mechanism of conceptual integration as well as relate it to other relevant constructs. We then proceed to discuss the presence of conceptual integration in teaching activities constituting our research data.

THEORETICAL BACKGROUND AND PREVIOUS RESEARCH

As mentioned in the introduction, creativity in education is usually tied to subjects such as arts, music, or drama. Generally speaking, creative individuals come up with novel ideas and produce original artifacts that combine elements in ways we have never encountered before. However, as proposed by Geld and her collaborators (Geld et al., 2022), if we consider the totality of human creative endeavors and the circumstances in which they come to life, we may notice that there are three fundamental categories of factors/circumstances underlying the inception of creative processes:

a) crises of various extents that threaten or endanger the fulfillment of basic human needs;

a) creation as an occupational process (problem-solvers, innovators and creators – from scientists to artists);

a) the human need to engage in creation for various personal and/or "therapeutic" reasons (from free-time activities to healing).

The three categories frequently overlap, and they are in no way discrete or clearly delineated. Likewise, there is significant fuzziness within catego-

[1] The issue received a lot of attention when Sir Ken Robinson, in his famous talk on *Technology, Entertainment and Design* (TED), asked the question: *Do schools kill creativity?*.

ries. Psychologists have struggled for decades to provide empirical evidence about the nature of creativity, that is, determine whether it is domain-general, domain-specific, or both (Baer, 1994; Barab & Plucker, 2002; Brown, 1989; Cramond, 1994; Csikszentmihalyi, 1999; Diakidoy & Spanoudis, 2002; Gardner, 1993; Han & Marvin, 2002; Kaufman & Baer, 2002; Lim & Plucker, 2001; Plucker, 1998, 1999; Sternberg, 2002).

Our discussion on creativity in education is primarily concerned with the characterization of creativity described under b), that is creation as an occupation process. If we wish to educate creative and innovative problem-solvers, we, as educators, must also be innovators who encourage creativity and understand its origins and underlying mental operations. The latter leads us to the central notion we discuss in this paper – the notion of conceptual integration as a mental operation underlying creativity (Fauconnier & Turner, 2002; Turner, 2014).

As already suggested, conceptual integration is pervasive and discernible across a spectrum of human creations.: from previously mentioned cartoon and children's book characters to architectural blends. Consider, for instance, Jean Nouvel's National Museum of Qatar, which draws inspiration from the desert rose, or the Sea Organ in Zadar, an architectural and musical installation that merges multiple elements and concepts, creating a harmonious and innovative structure. However, as already stressed, the mental operation of conceptual integration or blending largely happens subconsciously, and the results are emergent meanings that go unnoticed by our conscious mind. Probably the most complex examples of such emergent meanings are linguistic examples. Complex meanings are created with incredible ease and

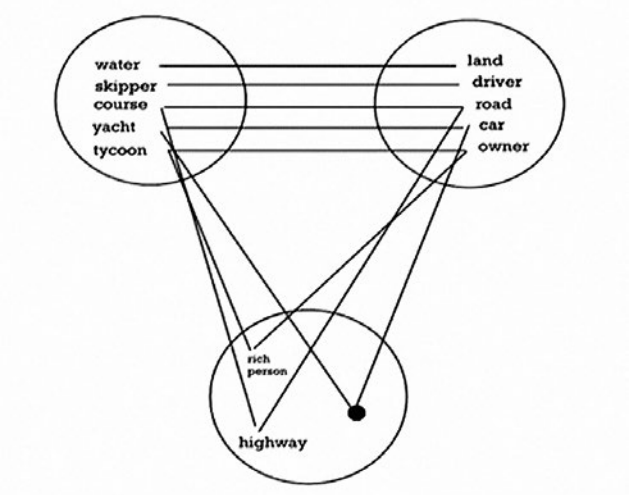

Figure 1. Land yacht – 'large, luxurious automobile' (Fauconnier & Turner, 2002: 357)

linguistic novelties are literally everyday phenomena. Let us illustrate the complexity of conceptual integration with a linguistic example proposed by Fauconneir and Turner (2002), see Figure 1.

The central question is how we get from linguistic units to conceptual elements and vice versa. It is obvious that the nominal compound ("land yacht") names two conceptual elements in two different mental spaces. The hearer/understander is directed to construct the rest. "Land" and "yacht" come from different domains – land as opposed to water. What the understander does is perform mappings between these two spaces: the yacht corresponds to the luxury car, the land to the water, the driver to the skipper, the road to the course and the owner to the tycoon. The conceptual integration of mental spaces depends on building analogical mapping. However, the outcome of the integration (*land yacht*) is not based on individual mappings of predictable counterparts. "Land" and "yacht" belong to two different domains and resulting mental spaces, but they are not conceptual counterparts. The meaning of the compound relies on the *emergent structure* that results from the blend of the two spaces.

This particular example is relatively straightforward in comparison to vast networks of mental spaces and conceptual integration that operate under a set of constitutive and governing principles. Still, it is a clear example of the complexity of our mind as well as its ease of creation. We run conceptual blends all the time, and most of the time without cognitive effort. In other words, the mechanism of creativity is available to everybody, but the question is how we can encourage its use. The mechanism enables us to combine elements that have probably never been combined before, and selectively project from one mental space to another. But how do we create conditions conducive to such processes? The nature of conceptual blending implies integration of seemingly different or unrelated elements, ideas, and domains of knowledge. This suggests that an important way to encourage creative processes in education is by creating opportunities for conceptual integration to occur. We would like to suggest that these opportunities are largely related, but not restricted, to the following: building cross-curricular collaboration, introducing inter-subject topics, and moving away from entrenched teaching practices that are bound to one discipline/subject/field. Furthermore, these opportunities arise from experiential learning that draws on a variety of experiences and contexts naturally abundant in diverse information and knowledge. This kind of abundance is crucial for creativity. Creators in all walks of life thrive in environments that enable them to recognize similarities in different (categories of) objects or experiences that may not be too conspicuous. We know that categories are fuzzy (Rosch, 1975), but in the process of categorization we

tend to disregard the differences and focus on the similarities. Conversely, in the process of creative work or creative problem-solving we often investigate different categories and look for elements that are usually disregarded. This investigative process involves re-conceptualization, it goes beyond conventional boundaries and implies alternative ways of completing a particular task or creating something new. Naturally, what matters is the purpose, the meaning behind what is created - be it linguistic or any other meaning. In sum, the mechanism of conceptual integration has boundless potential and may produce an infinite number of emergent structures. In the subsequent section, we present a qualitative study that aimed to determine the nature of conceptual integration in teaching. The study drew upon the theoretical framework of conceptual blending and adopted an exploratory approach. Its primary objective was to gather insights into teachers' ideas and creative practices in the classroom through an open-ended data collection method.

SAMPLE AND DATA COLLECTION

In this exploratory study, 18 Croatian middle-school and high-school teachers, specializing in English, German, or Math, were invited to participate. Their involvement in the study entailed recollecting and describing two teaching activities they perceived as the most "creative."

The decision to focus on teachers of English and German was influenced by the fact that these languages are the most popular foreign-language choices among Croatian students. Moreover, the inclusion of Math teachers was motivated by the subject’s status as a fundamental subject taught throughout formal education and its reputation as one of the traditionally more demanding school subjects. It's also important to stress a distinct nature of language teaching, as the language being taught functions both as a medium of communication and as the core subject itself. This unique attribute sets it apart from all other subjects. Consequently, Math was chosen as a subject with significantly different characteristics to provide a balanced representation in the study.

The teachers were selected using the snowball sampling method. The mean age value was 45 (ranging between 30 and 64). Majority of them (33%) had between 15 and 19 years of teaching experience, 28% had between 20 and 24, 6% between 25 and 30, whereas 11% of them had more than 30, less than 9, and between 10 and 14 years of experience.

Each participant (3 male, 15 female) answered an on-line questionnaire that was prepared via Google Forms and distributed through the direct mail with thorough instructions including a short project overview and instructions on how to fill in the central rubrics pertaining to the selected creative activities. The rubrics contained the questions about the following:

1. type of activity – online[2] vs. classroom (face-to-face);
2. description of the activity and teaching material;
3. reaction of the students (possible differences in comparison to their usual reactions in class);
4. the teacher's opinion about what makes the activity creative;
5. the "inspiration" for the activity;
6. how the activity selected is different from other classroom activities.
7. There were 37 activities in total (14 in German, 12 in English, and 11 in Math classes). Distribution of activities is provided in Figure 2. They are shown at the grade level (6th and 8th grades of middle school; 2nd and 4th grades of high school). At the level of activity type, there were 17 classroom activities (6 German, 6 Math and 5 English) and 20 online activities (8 German, 7 English, and 5 Math). Figure 3 visualizes the distribution of classroom vs online activities per each class, but also per school level.

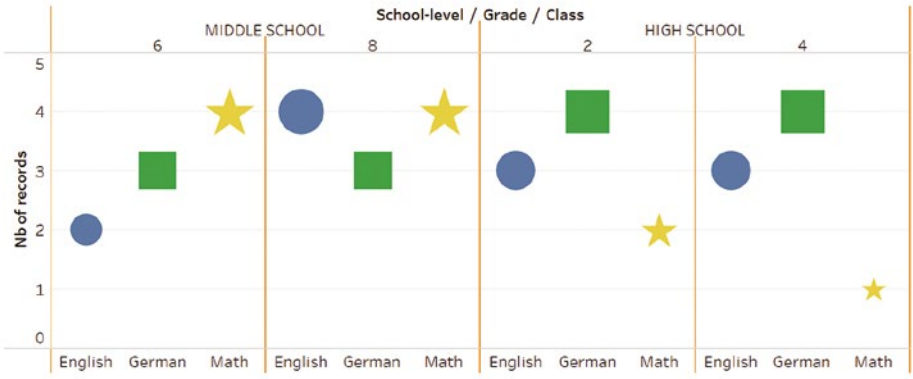

Figure 2. Distribution of activities per class [English vs. German vs. Math] per grade

[2] This option was included due to the transition to online classes during the pandemic. The period was extremely challenging for all the teachers, but it also served as a trigger for their resourcefulness and creativity.

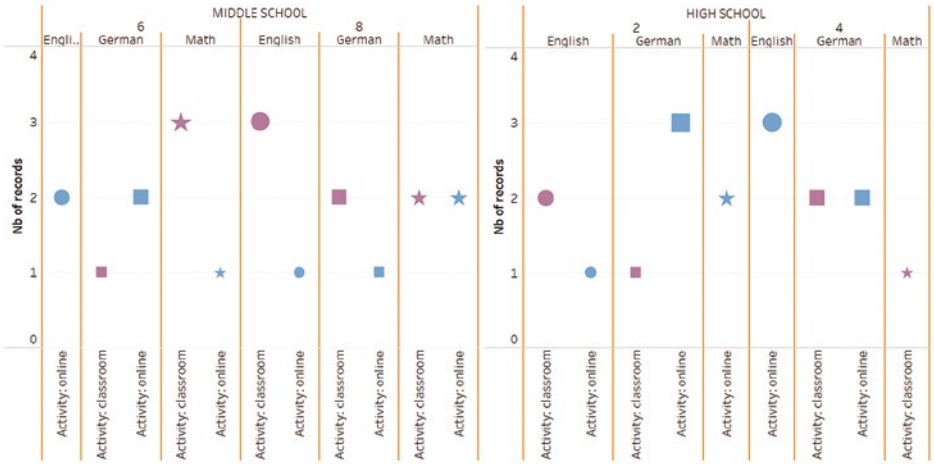

Figure 3. Distribution of classroom vs. online activities per class per grade

QUALITATIVE ANALYSES AND DISCUSSION

There were two steps in the analysis. First, we looked at the participants' replies according to the rubrics in the questionnaire (the six questions listed in the previous section). Second, we analyzed the replies to identify the presence of the elements suggesting conceptual integration. As previously explained, the mechanism of conceptual integration enables us to combine elements that have probably never been combined before, and selectively project from one mental space to another. In teaching, the process of combining diverse elements is not random, rather, it is oftentimes a deliberate cognitive effort. It is about purposefully seeking out connections between different concepts and integrating them in a way that enhances our understanding or generates new insights. The conditions that enable such purposeful integrations of seemingly distant elements, concepts and ideas thrive in the environment abundant in multimodal input characteristic of the real-world experience. In the context of education, this kind of environment is related to experiential learning that combines in-classroom with out-of-classroom activities; flipped-classroom activities that demonstrate learners' integration of real-world ideas with the ideas related to the content they had to prepare; cross curricular topics that draw on the learners' knowledge from two or more school subjects; problem-solving by combining skills from different domains and areas (digital and physical, math and language, language and arts, etc.).

Among the 37 activities selected and described by the research participants, the authors identified 26 activities that exhibited creativity resulting

from conceptual integration. The remaining activities merely introduced changes in the activity format (e.g., digital vs. paper-and-pen) or incorporated elements to enhance enjoyment (e.g., quizzes on Kahoot). However, these modifications did not engage either the teacher or the learner in a genuinely creative process. Considering the paper's scope, the following section will present detailed descriptions of three exemplary activities chosen from the 26 cases of conceptual integration. Subsequent analyses will demonstrate the specific aspects of creativity that were the primary focus of our investigation. As mentioned earlier, we will begin by presenting the participants' responses based on the rubrics used in the questionnaire. Subsequently, we present the analysis related to the nature of conceptual integration in the selected teaching activities.

Example 1

English teacher (more than 30 years of teaching experience)

Class of 17 students graduating high school, online instructions followed by a team project.

Description of the activity:

The general topic was *Ecology*, the focus was on microplastics. Non-biodegradable microplastic particles (used instead of natural ingredients) affect biological diversity and human health. Students were given instructions to team up, conduct an experiment, discuss the results, and write down their observations (what they did, what they saw, felt, smelled, etc.). The task was to use shower peeling gel containing polyethylene because their nanoparticles endanger our ecosystem. They were instructed to dissolute the gel in water and then drain the mixture through a plain paper coffee-machine filter. The aim was to make microplastic beads visible and tangible on the filter. The students followed the instructions and, using simple items (a bowl, a burning candle, and a coffee filter), they drained the mixture, let it dry, scraped the beads of microplastics, and burned them on a spoon over the heat of the candle. They could detect the smell of plastic, which provided evidence that non-biodegradable microplastic particles are used in a product many people use on a daily basis.

The students' reaction:

They were engaged and they loved their task. They stressed teamwork as central to creative endeavors. Their work was published on HundrED (see https://hundred.org/en), an international organization dedicated to innovation in education.

What the teacher identifies as creative in the activity:

She managed to create conditions for developing 21st century skills by setting-up a different learning environment (online discussion about the task, experiment conducted in teams, problem-based learning, and project-based learning). She singles out the importance of "creating experience" and "active participation".

The teacher's inspiration for the activity:

The students' *Pledge to Expect Respect* that inspired her to foster teamwork and respect – students respecting each other and everybody/everything that surrounds them.

How the activity is different from other classroom activities:

The activity activated all the students – there was a feeling of a joint venture towards a common goal.

In Example 1, conceptual integration was prompted in a variety of ways. The teacher decided to engage students in a hands-on activity rather than reading a text about microplastics, which opened opportunities for creative use of household objects (coffee filter, spoon, candle) and students' engaging use of technology to store their own data rather than simply search for ready-to-use information. Thus, they constructed new knowledge and prompted the emergence of meaning by blending what they learned in other subjects with what they have found out during the experiment. Cross-curricular teaching, just like interdisciplinary study programs, are the strongest foundation for educating innovative thinkers and problem solvers. Furthermore, collaboration is by its very nature an avenue for triggering conceptual integration. Human experiences are diverse, and they constitute unique input during interaction, which is crucial for emergence of new meaning(s) and construction of knowledge. The critics may argue that this teacher is not creative because the task itself was obviously borrowed from a science class. However, we wish to argue that creative teachers are not only those who can invent and design entirely novel tasks and activities, but also those who recognize creative tasks and employ them in their teaching, who adapt content to make it engaging and relevant for students, and those who create environment that nurtures their students creativity by enabling them to observe and experiment.

Example 2

Math teacher (more than 30 years of teaching experience)

Class of 22 students, sophomores in high school, an online activity.

Description of the activity:

The general topic was *Trigonometry*, with the focus on its application. The trigonometric task involved determining the height of an inaccessible vertical object based on the data that the students had to determine themselves by observing that object from different distances. The teacher created an interactive applet on GeoGebra[3] (https://www.geogebra.org/m/QAQYws6B) to simulate this activity, which was subsequently accessed 2500 times, based on log data. The task did not include the usual triangles, but a boat sailing towards a lighthouse (see Figure 4). The students determined the input data by moving the boat on the sea surface (drag and drop). The goal of the task was to obtain the same result based on different input (different angles). In a synchronous online classroom setting, the teacher could see what answers the students submitted in real time.

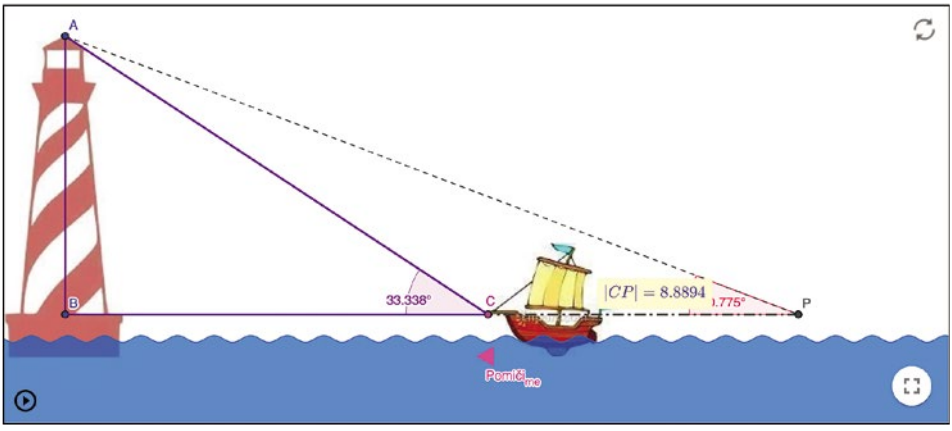

Figure 4. Trigonometry task - the boat and the lighthouse (taken from GeoGebra)

The students' reaction:

The students acknowledged that trigonometry can be applied practically. They found the animation very interesting: they could see the relationship between the angle and the side of the triangle, i.e. the height of the observed object. Also, they appreciated the animated visualization which helped them figure out how to reduce unnecessary information and see where to start.

[3] GeoGebra (https://www.geogebra.org/) is a dynamic international math software for all levels of education that integrates geometry, algebra (the term itself is a blend >> geometry and algebra), spreadsheets, graphing, statistics and calculus in one engine, a platform with free digital tools for class activities, a collaborative whiteboard and more. The author and creator of our Math example is a Croatian teacher actively participating in co-creating the software and translating it into Croatian.

What the teacher identifies as creative in the activity:

He thinks that setting the task in a vivid multimedia animation of a maritime-historical environment was situationally significant as the school is situated on the very coast, next to the sea. The students could relate to the task and realize the potential of trigonometry in solving real-life problems.

The teacher's inspiration for the activity:

Realization that students need to be more involved in determining the input data, instead of having data provided and ready to be manipulated. He aimed at overriding routine by active involvement.

How the activity is different from other classroom activities:

This online activity was more interactive than other classroom activities. The input data was not fed to students, everyone had a different task and still got the same result. The teacher introduced a different perspective, the one from which his students could observe and show proactivity and creativity in performing their tasks.

In Example 2, conceptual integration is present in the teacher's attempt to integrate the abstract with the concrete - the schematicity of triangles learners usually draw with the concreteness of the triangle formed by the verticality of the lighthouse and the position of the boat. Generally speaking, every simulation is a step towards achieving an embodied cognitive and affective experience[4] - when learners engage in activities that simulate real-life situations, they are not only thinking about the concepts but also emotionally connecting with the experience. In turn, the closer our learners are to experiencing and the more they get engaged in experiential learning, the more likely they are to construct new knowledge. By being doers instead of just observers or users, they are not only cognitively, but also emotionally engaged and motivated. Moreover, the task is designed to reflect the learners' natural surroundings. This enhances the relevance of the task and creates a task-related space, with compressed spatial, temporal and other relations, that binds the teacher with his learners. As expected for math, this task is an attempt to contextualize the abstract. The learners were prompted to recognize relationships and find a solution to the problem in a new and creative way.

[4] Contemporary trends in cognitive science, such as 4E cognition (extended, embedded, embodied and enactive), present a tremendous potential in re-thinking the future of education. They are aligned with successful traditional approaches, such as experiential learning, and may serve as a niche to investigate various aspects of modern education - e.g. the role of technology and its efficacy in teaching.

Example 3

German teacher (10 – 14 years of teaching experience)

Class of 13 students, Grade 6 of middle school, a classroom (face-to-face) activity.

Description of the activity:

The general topic was *verbal description of visual representations*. The teacher decided to use a portrait of a young lady. She presented her German-class students with 20 figurative and abstract portraits made by students from grades 7 and 8 in their art classes. The German-class students were asked to choose what kind of activity they would like to do. They voted and the outcome of the vote was the following: they wish to describe figurative portraits made by different students, but depicting the same lady. The students were paired up and each pair picked a portrait they wanted to describe. Their task was to make up the title for the portrait, provide a short description, and then describe how it made them feel. They were given basic framework and language-related guidelines, but the rest was their own work and spontaneous creative flow. After completing their descriptions, the students were asked to present their work in class and self-evaluate their engagement in the activity.

The students' reaction:

All the students enjoyed working in pairs and "negotiating the meaning" of the portrait. They liked the fact that they "moved away" from their textbooks. Although given some guidelines on how to describe the portrait, they still felt they had enough freedom to express their own visions of the portrait as well as develop their own ideas.

What the teacher identifies as creative in the activity:

Combining visual arts and the German language. The teacher emphasizes the fact that the students were given freedom to choose what type of portrait and which portrait to describe. They were encouraged to actively view and individually interpret a piece of visual art which activated their imagination and enabled them to "communicate" with the authors of the portraits via their work. The pair work enabled students to develop their soft skills.

The teacher's inspiration for the activity:

The teacher felt it was necessary to fulfill her learners' need to express themselves spontaneously and creatively in words and images.

How the activity is different from other classroom activities:

It is a cross-curricular topic where works of art created in an art class by older students served as a prompt and inspiration for writing creative and

imaginative texts in a German class. The texts the students produced "could not be wrong" because the teacher asked them to provide their own interpretation. All the students actively participated in the activity.

In Example 3, the teacher herself clearly identified conceptual integration by saying that the activity is creative because it combines visual arts and the German language. The learners displayed enthusiasm for stepping beyond the confines of the textbook. The teacher structured the activity in a captivating manner - the learners, metaphorically speaking, moved into their fellow students' space by describing something they had previously created in their arts class. Also, the students were paired up and had a chance to "negotiate the meaning" of the portrait in the process of making up the title. The process itself prompted the emergence of meaning through the learners' identification of the most salient and/or inspiring elements of the portrait, ultimately leading to the creation of titles that encapsulated the content's essence. In sum, the activity encompasses several components that cultivate an environment conducive to conceptual integration and the emergence of meaning. First, a cross-curricular topic enriched with a strong personal element. The learners stepped out of their language classroom and stepped into an arts class where they discussed their peers' work. The two classroom "worlds" coalesced. Second, the act of pairing students and allowing them to select portraits paved the way for individuality on the one hand and collaborative creation on the other. Each pair crafted their own distinctive descriptions and emotional reactions. Third, the task of crafting the titles is a tremendously creative process. Abstract art encourages viewers to think beyond the obvious and imagine alternative meanings. It prompts metaphorical thinking and mappings from one domain of knowledge to another. The students had to tap into various corners of their knowledge, imagine and re-imagine to come up with original and imaginative descriptions that might not be immediately apparent to others. Moreover, creating titles required analysis and critical assessment of the visual elements of the portrait. The students had to identify significant features and consider how to encapsulate those features in a concise and impactful title.

CONCLUSION

A considerable number of our participants showed that they know how to foster creativity in their classrooms. However, as previously stated, our sample was collected using a snowball sampling method – we identified a few creative teachers and asked them to refer other teachers they find creative. Our sample is not representative of the general teacher population. Our

primary aim was to analyze the activities these teachers find creative and determine their characteristics in relation to the cognitive mechanism of conceptual integration.

Modern language teaching is by default layered with conceptual integration due to its nature: it is both the medium of instruction and the object of teaching. Furthermore, language is intertwined with human cognition and experience, and the construction of meaning is an ongoing process that happens without our conscious effort, as demonstrated in Section 1 in the case of emergent meaning of *land yacht*. However, even though the cognitive mechanism of conceptual integration is always at work by driving complex mental operations in language, math, and elsewhere, we believe its potential is not strategically and consciously employed to foster creation of emergent meanings and novel ideas in education. Fostering creativity, active problem-solving and innovation necessitate making conscious efforts to design teaching activities that require activation of knowledge from various mental spaces, that is different domains of knowledge. Learners need to engage in more cross-curricular topics, they need to step out of their classrooms, learn by observing and experiencing natural and social phenomena, and become team players who learn from each other.

The future of education requires changing our environment by opening new spaces for innovation to happen. Education needs to not only react to changes that are already happening but affect such changes. This is aligned with Peschl's idea that innovation is *"about future states of the environment and about changing it in a future-oriented manner"* (Peschl, 2019: 6). This view is a step forward (or away) from traditional approaches to innovation, as it assumes that, in order to create conditions for novelty to arise, we need to proactively influence and shape the environment, rather than just react to change as it occurs. One of the preconditions for changing the educational environment is challenging a stereotypical school setting. It implies reevaluating and reconsidering the established norms and practices in education, with the goal of introducing new and innovative approaches that can lead to positive changes in the learning environment. It's worth stressing that the changes we are proposing are not revolutionary. They have been long overdue and are essential for the progression of education. Experiential learning, cross-curricular and interdiciplinary topics, teamwork, conditions that foster construction of knowledge rather than "transmission" of information are far from new. Problem-solving, critical thinking, and creativity have been buzz words for decades. However, education is still failing to keep up with the requirements of modern society. Schools need to develop and embrace adaptable and flexible curricula, and teachers acknowledge the fact that they do

not serve as all-knowing narrators guiding the unfolding story of knowledge. Consequently, the school environment transforms into an arena that welcomes the integration of seemingly disparate elements, ideas, and knowledge domains. This stands in stark contrast to the rigid structures of tightly packed curricula that merely deliver facts to students. Instead, teachers and learners collaborate within a fluidly organized setting. At the heart of this setup lies the concept of a metaspace, an intermediary structure that encompasses learning material rooted in and connected to real-world inquiries and challenges.

REFERENCES

Antović, M. (2018). Persuasion in musical multimedia: A Conceptual Blending Theory Approach. In J. Pelclova & W. Lu (Eds.), *Persuasion in Public Discourse* (pp. 303–327). Amsterdam: John Benjamins.

Baer, J. (1994). Divergent thinking is not a general trait: A multi-domain training experiment. *Creativity Research Journal*, 7, 35–36.

Barab, S. A., & Plucker, J. (2002). Smart people or smart contexts? Talent development in an age of situated approaches to learning and thinking. *Educational psychologist*, 37, 165–182.

Brown, R. T. (1989). Creativity: What are we to measure? In J. A. Glover, R. R. Roning & C. R. Reynolds (Eds.), *Handbook of Creativity* (pp. 3–32). New York: Plenum.

Csikszentmihalyi, M. (1999). Implications of a system perspective for the study of creativity. In R. J. Sternberg (Ed.), *Handbook of Creativity* (pp. 313–335). New York: Cambridge University Press.

Cramond, B. (1994). We can trust creativity tests. *Educational leadership*, 52(2), 70–71.

Diakidoy, I. N., & Spanoudis, G. (2002). Domain specificity in creativity testing: A comparison in performance on a general divergent-thinking test and a parallel domain- specific test. *Journal of Creative Behaviour*, 36, 41–61.

Fauconnier, G., & Turner, M. (2002). *The Way We Think: Conceptual Blending and the Mind's Hidden Complexities*. New York: Basic Books.

Gardner, H. (1993). *Creating Minds*. New York: Basic Books.

Geld, R., Jović, A., Tomić, D., Bojanjac, D., Hromatko, I.; Sović Kržić, A., Tonković, M., & Jelača, M. (2022). Education-based Situated Creativity. In J. Budak, M. Holy & R. Medić (Eds.), *Creative Industries and Experience Economy* (pp. 197–211). Zagreb: VERN' University & The Institute of Economics.

Gómez-Ramírez, D. A. J. (2020). *Artificial Mathematical Intelligence: Cognitive, Metamathematical, Physical, and Philosophical Foundations*. New York: Springer.

Han, K., & Marvin, C. (2002). Multiple creativeness? Investigating domain-specificity of creativity in young children. *Gifted Child Quarterly*, 46, 98–109.

Kaufman, J. C., & Baer, J. (2002). Could Stephen Spielberg manage the Yankees? Creative thinking in different domains. *Korean Journal of Thinking and Problem Solving*, 12(2), 5–14.

Koestler, A. (1964). *The Act of Creation*. New York: Macmillan.

Lakoff, G., & Núñez, R. E. (1997). The metaphorical structure of mathematics: Sketching out cognitive foundations for a mind-based mathematics. In L. D. English (Ed.), *Mathematical reasoning: Analogies, metaphors, and images* (pp. 21–89). Mahwah, New Jersey: Lawrence Erlbaum Associates.

Lim, W., & Plucker, J. (2001). Creativity through a lens of social responsibility: Implicit theories of creativity with Korean samples. *Journal of Creative Behaviour*, 35, 115–130.

Maldonado, R. (1999). *Spanish Causatives and the Blend*. Paper presented at the 6th International Cognitive Linguistics Conference.

Peschl, M. F. (2019). Design and innovation as co-creating and co-becoming with the future. *Design Management Journal*, 14(1), 4–14. https:/doi.org/10.1111/dmj.12049.

Plucker, J. (1998). Beware of simple conclusions: The case for content generality of creativity. *Creativity Research Journal,* 11, 179–182.

Plucker, J. (1999). Reanalysis of student responses to creativity checklists: Evidence of content generality. *Journal of Creative Behaviour*, 33, 126–137

Rosch, E. (1975). Cognitive Representations of Semantic Categories. *Journal of Experimental Psychology: General*, 104(3), 192.

Sondergaard, M. (1999). *Blended Spaces in Contemporary Art*. Paper presented at Beyond Babel: 18th Annual Conference of the Western Humanities Alliance.

Sternberg, R. J. (2002). Creativity as a decision. *American psychologist*, 57, 376.

Thagard, P., & Stewart, T. C. (2011). The AHA! Experience: Creativity Through Emergent Binding in Neural Networks. *Cognitive Science*, 35(1), 1–33.

Turner, M. (2001). *Cognitive Dimensions of Social Science*. Oxford: Oxford University Press.

Turner, M. (2014). *The Origin of Ideas: Blending, Creativity, and the Human Spark*. Oxford: Oxford University Press.

Woźny, J. (2018). *How we understand mathematics. conceptual integration in the language of mathematical description*. New York: Springer.